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Tatsuya Usami

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EXAMINER

MALDONADO, JULIO J

ART UNIT

PAPER NUMBER

2823

DATE MAILED: 12/15/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/851,313

Applicant(s)

USAMI, TATSUYA

Examiner

Julio J. Maldonado

Art Unit

2823

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 14 November 2006.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,4,5,8,31,32 and 34-56 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,4,5,8,31,32 and 34-56 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
- ☒ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- ☒ Notice of References Cited (PTO-892)
- ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- ☐ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date _____.
- ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- ☐ Notice of Informal Patent Application
- ☐ Other: _____.

DETAILED ACTION

1. The rejection as set forth in the office action mailed 06/19/2006 is withdrawn in further review of the prior art of record.
2. Claims 1, 4, 5, 8, 31-32 and 34-56 are pending in the application.

Claim Objections

3. Claim 39 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Claim 39 recites, "...therein said insulation layer comprises a methylated hydrogen silsesquioxane (MHSQ) film". However, said MHSQ was already recited in independent claim 42, thus failing to further limit the claim.
4. Claim 43 is objected to because of the following informalities: claim 43 recites "...said multi-layered insulation film comprise substantially uniform...". The term "substantially uniform" in claim 43 is a relative term which renders the claim indefinite. The term "substantially uniform" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. Appropriate correction is required.
5. Claim 47 is objected to because of the following informalities: claim 47 recites "...wherein a greatest thickness of said second...". The term "greatest thickness" in claim 47 is a relative term which renders the claim indefinite. The term "greatest

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thickness " is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. Appropriate correction is required.

6. Claim 48 is objected to because of the following informalities: claim 47 recites "...said second insulation layer comprises a thin layer...". The term " thin layer " in claim 48 is a relative term which renders the claim indefinite. The term " thin layer " is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. Appropriate correction is required.

Claim Rejections - 35 USC § 112

7. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

8. Claims 1, 5, 41 and 42 rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. In reference to claims 1, 5, 41 and 42, applicants recite, "...a second insulation layer comprising a polysiloxane compound having an Si-H group and formed on and adhering to a top of said organosiloxane film of said first insulation layer...wherein said second insulation layer comprises a methylated hydrogen silsesquioxane (MHSQ) layer which adheres to said organosiloxane film and said inorganic material...". This is found to be indefinite because the polysiloxane material (which does not have to be MHSQ) is already formed and adhering over said organosiloxane material. It is suggested to amend the claims to

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recite --a second insulation layer comprising a polysiloxane compound having an Si-H group and formed on and adhering to a top of said organosiloxane film of said first insulation layer...wherein said polysiloxane compound is a methylated hydrogen silsesquioxane (MHSQ) layer which adheres to said organosiloxane film and said inorganic material--.

9. Claim 35 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. In reference to claim 35, applicants recite, "...wherein said second insulation layer comprises a first layer and a second layer placed in said first layer". However, this is found to be indefinite because claim 1, from which claim 35 depends therefrom recites a layer of MHSQ adhering over a first and a third insulation layer, thus failing to particularly point out and distinctly claim the subject matter.

Furthermore, the submitted disclosure teaches, "...The multi-layered insulation film for the present invention contains the first, second and third insulation layers, of which the first layer is preferably thicker than the others, because the present invention tries to effectively utilize the excellent dielectric, planarizing and gap-filling characteristics of the organic material of low constant as the constituent for the first insulation layer. The multi-layered insulation film for the present invention may have another layer of, e.g., MSQ, placed in the second insulation layer..." (Instant page 17, lines 8 – 17). Therefore, the recited limitation in claim 35 is part of another embodiment of the invention, different from the embodiment recited in claim 1. The examiner suggests the applicants to cancel the claim or change the scope of said claim 35.

Claim Rejections - 35 USC § 103

10. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

11. Claims 1, 4, 5, 8, 31, 32 and 34-55 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yau et al. (U.S. 6,054,379, hereinafter Yau) in view of Allada et al. (6,218,317 B1, hereinafter Allada) and the Applicants' Admitted Prior Art (hereinafter the prior art).

In reference to claims 1, 5, 39, 40, 41, 42, 46 48, 49, 52, 54 and 55, Yau (Fig.10H) teaches a multilayered dielectric stack comprising a first insulation layer (710) comprising an polymeric organic material having a dielectric constant which is lower than a silicon oxide dielectric constant; a second insulation layer (714) made of a polysiloxane compound having an Si-H group and formed on and adhering to a top of said first insulation layer (710); a third insulation layer (716) comprising an inorganic material and formed on and adhering to a top of said second insulation layer (714); and a plurality of wires (724) which are formed in groves formed in said multi-layered dielectric stack filling a space between said wires (724), wherein said second insulation layer (714) comprises a hydride organosiloxane which adheres to said first insulation layer (710) and said third insulation layer (716), said second insulation layer (714) improves adhesion between said first insulation layer (710) and said third insulation layer (716) (Yau, column 13, lines 12 – 663).

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Yau fails to disclose wherein said second insulation layer comprises methylated hydrogen silsesquioxane film (MHSQ) at a thickness of about 50 nm, wherein said dielectric layer includes repeating units of $(\text{SiCH}_3\text{O}_2)_n$, $(\text{SiO}_2\text{H})_n$ and $(\text{SiO}_3)_n$, wherein a molar ratio of $(\text{SiO}_2\text{H})_n$ to a total of said repeating units is at least 0.2. However, Allada (Figs.1a-1b) in a related art to the formation of copper interconnect structures teaches a second insulating film comprising a methylated hydrido organo siloxane polymer (HOSP), labeled MHSQ, wherein said polymer can be formed by spin coating processes or by conventional CVD processes (Allada, column 2, lines 7 – 67). As to the limitation that the dielectric layer includes repeating units of $(\text{SiCH}_3\text{O}_2)_n$, $(\text{SiO}_2\text{H})_n$ and $(\text{SiO}_3)_n$, wherein a molar ratio of $(\text{SiO}_2\text{H})_n$ to a total of said repeating units is at least 0.2, the dielectric methylated hydrido organo siloxane polymer of Allada teaches upon the recited limitation. See the Response to Arguments section of this office action.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to use the insulating layer as taught by Allada in the interconnect formation structure of Yau, since this dielectric layers exhibit low dielectric constants and also have better adhesion properties than conventional dielectric layers (Allada, column 1, lines 37 – 60 and column 2, lines 36-48), and furthermore, because the selection of a known material based on its suitability for its intended use supported a prima facie obviousness (MPEP 2144.07).

The combined teachings of Yau and Allada fail to disclose wherein said MHSQ film comprises a thickness of about 50 nm. Notwithstanding, it would have been an obvious matter of design choice bounded by well known manufacturing constraints and

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ascertainable by routine experimentation and optimization to choose these particular dimensions because applicant has not disclosed that the dimensions are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical, and it appears prima facie that the process would possess utility using another dimension.

Indeed, it has been held that mere dimensional limitations are prima facie obvious absent a disclosure that the limitations are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical. See, for example, *In re Rose*, 220 F.2d 459, 105 USPQ 237 (CCPA 1955); *In re Rinehart*, 531 F.2d 1048, 189 USPQ 143 (CCPA 1976); *Gardner v. TEC Systems, Inc.*, 725 F.2d 1338, 220 USPQ 777 (Fed. Cir. 1984), cert. denied, 469 U.S. 830, 225 USPQ 232 (1984); *In re Dailey*, 357 F.2d 669, 149 USPQ 47 (CCPA 1966).

The combination of Yau and Allada teach wherein the first insulating layer is selected from a group including parylene, FSG, silicon oxide, or the like (Yau, column 13, lines 12 – 16) and wherein metal lines can be included on the substrate wherein said first dielectric layer covers a space between said metal lines (Yau, column 10, line 18 – column 11, line 43), but fail to disclose wherein the first insulation layer is an organopolysiloxane including methyl silsesquioxane (MSQ). However, the prior art (Instant Figs.8a-9b) teaches a device having a plurality of gate electrodes (60) having diffusion regions (54) formed on a substrate (51); and a first insulation layer (55) over said substrate (51) having a wiring connection between the gate electrodes through a diffusion region (54) locates between said gate electrodes (60), wherein said first

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insulation layer includes methyl silsesquioxane, and wherein said wiring connects said gate electrodes to an upper level (Instant page 2, lines 5 – 8 and page 5, lines 9 – 24).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the teachings of Yau, Allada with the teachings of the prior art to substitute the dielectric material taught by Yau for the material disclosed by the prior art because using MSQ reduces crosstalk between metal wires (Instant page 2, lines 12 – 15) and because the selection of a known material based on its suitability for its intended use supported a prima facie obviousness. MPEP 2144.07.

In reference to claims 4 and 8, the combined teachings of Yau, Allada and the prior art teach wherein said third insulation layer comprises at least one material selected from the group including silicon oxide (Yau, column 13, lines 19 – 22).

In reference to claim 31, the combined teachings of Yau, Allada and the prior art fail to expressly teach wherein said dielectric constant of said first insulation layer is no greater than 3.5. However, the combination of Yau, Allada and the prior art teach the same material (i.e., MSQ) used for the first insulation layer (Instant page 2, lines 5 – 8 and page 5, lines 9 – 24). Therefore, the combination of Yau, Allada and the prior art inherently teach on the claimed invention.

In reference to claims 34 and 47, the combined teachings of Yau, Allada and the prior art teach wherein said first insulation layer comprises a thickness greater than a thickness of said second insulation layer; and wherein said first insulation layer can have a thickness greater than a thickness of said third insulation layer (Yau, column 13, lines 12 – 22).

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In reference to claim 37, the combined teachings of Yau, Allada and the prior art teach wherein a bottom of said groove is formed on a same surface as said first insulation layer (Yau, Fig.10H).

In reference to claim 38, the combined teachings of Yau, Allada and the prior art teach wherein said plurality of wires comprises copper wires (Yau, column 13, lines 47 – 63).

In reference to claim 43, the combined teachings of Yau, Allada and the prior art teach wherein said first insulation layer, said second insulation layer and said third insulation layer of said multi-layered insulation film comprise substantially uniform widths (Yau, Fig.10H).

In reference to claim 44, the combined teachings of Yau, Allada and the prior art teach wherein a surface of said multi-layered film is substantially coplanar with a surface of said plurality of wires (Yau, Fig.10H).

In reference to claim 45, the combined teachings of Yau, Allada and the prior art teach wherein said second insulation layer is formed by plasma CVD (Yau, column 4, line 19 – column 5, line 19).

In reference to claim 53, the combined teachings of Yau, Allada and the prior art teach a silicon nitride layer, said first insulation layer being formed in said silicon nitride layer and said plurality of grooves having a bottom defined by an upper surface of said silicon nitride layer (Allada, column 2, lines 7 – 57).

In reference to claims 50, 51 and 56, the combined teachings of Yau, Allada and the prior art teach wherein the substrate further includes a plurality of gate electrodes

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formed thereon; and a plurality of impurity diffusion regions formed in the semiconductor substrate, wherein said first, second and third insulation layers are formed on said plurality of gate electrodes, and wherein said plurality of grooves comprises a plurality of contact holes formed in said first, second and third insulation layers on said plurality of impurity diffusion regions and between said plurality of gate electrodes (Instant Figs.8-9, and page 4, line 1 – page 6, line 13). Further support of a multilayered dielectric stack formed over a substrate having the recited gate electrodes and diffusion regions can be found in Lu et al. to U.S. 6,008,540 (Fig.1g and column 5, line 50 – column 6, line 67).

Response to Arguments

12. Applicant's arguments filed 11/14/2006 have been fully considered but they are not persuasive.

Applicants argue, "...In contrast to Yau which is directed to a method of depositing an oxidized organo silane film, Allada is intended to address the problems involved with forming an undoped silicon glass (USG) hardmask on a polymer-insulated material without taking out a wafer from a spin-truck device, by producing multilayered wires in which both the hardmask and a layered insulation material are capable of being spin-coated. Further, in complete contrast to Yau and Allada, Chen is intended to provide a method for chemically and mechanically controlling the chemical mechanical polishing (CMP) characteristics of polysiloxanes which have low dielectric constants, and the AAPA simply teaches forming a silicon oxide film on a methyl silsesquioxane...Applicant respectfully submits that these reference are unrelated, and no person or ordinary skill in the art would have considered combining these disparate

references, absent impermissible hindsight...". In response to this argument, applicants assert the prior art of records teaches the argued differences. However, it is submitted that the prior art of record properly teaches upon the claimed invention.

Yau teaches an interconnect structure including a dielectric stack, wherein said dielectric stack further includes a first dielectric layer, a second dielectric layer and a third dielectric layer. In Yau, the first dielectric layer is an intermetal dielectric layer, such as parylene, FSG, silicon oxide, or the like (Yau, column 13, lines 12 – 15). The second dielectric layer of Yau, an adhesive layer, is an oxidized organo silane layer. Finally the third layer of Yau is selected from the group including silicon oxide or silicon nitride (Yau, column 13, lines 19 – 21). In Yau, the first dielectric layer is open to any kind of intermetal dielectric layer as long as it has similar properties such as low dielectric layer material (parylene, FSG). Having this in mind, the prior art teaches an interconnect structure including an intermetal dielectric layers such as MSQ (Instant page 2, lines 5 – 8 and page 5, lines 9 – 24). Furthermore, Allada teaches an interconnect structure including a dielectric stack, wherein said dielectric stack further includes a first intermetal dielectric layer, a second dielectric layer, and a third intermetal dielectric layer, wherein the first and third intermetal dielectric layer are open to any dielectric layer as long as they're polymeric interlayers, and wherein said second dielectric layer is a methylated oxide hardmask, that can further provide improved adhesion between dielectric layers within said dielectric stack, and wherein said hardmask can be made of HOSP and can be deposited by a CVD process (Allada, column 1, lines 51 – 55, lines 61 – 63, column 2, lines 11 – 25 and lines 49 – 62).

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Furtherstill, according to Chen et al. (Effects of slurry formulations on chemical-mechanical polishing of low dielectric constant polysiloxanes: hydrido-organo siloxane and methyl silsesquioxane) in Fig.1, methylated hydrido organo siloxane polymer (HOSP) includes repeating units of $(\text{SiCH}_3\text{O}_2)_n$, $(\text{SiO}_2\text{H})_n$ and $(\text{SiO}_3)_n$, wherein a molar ratio of $(\text{SiO}_2\text{H})_n$ to a total of said repeating units is at least 0.2 and further includes Si-H bonds and CH_3 -Si bonds. Accordingly and for purposes of this office action, HOSP is labeled methylated hydrogen silsesquioxane (MHSQ).

From the teachings of the prior art of record, it is submitted that Yau, Allada and the prior art are part of the same field of endeavor, that is, an interconnect structures. It is also submitted that the first intermetal dielectric layer of Yau can be made of materials such as parylene, FSG and silicon oxide (which are polymeric materials) as asserted by the applicants, and is also to other materials that could be used as intermetal dielectric layers, such as MSQ (another polymeric material) as disclosed in the prior art. Furthermore, it is submitted that the hardmask of Allada (once again, a polymeric material) can be used as an adhesive layer and is an oxidized organo silane layer that can replace the adhesive layer (which is a polymeric material) of Yau. Therefore, the combination of the Yau, the prior art and Allada teach upon the claimed invention. "The selection of a known materials based on its suitability for its intended use supported a prima facie obviousness". See MPEP 2144.07.

Applicants further argue, "...neither, Yau, nor Allada, nor Chen, nor the AAPA, nor any alleged combination thereof teaches or suggest 'wherein said second insulation layer comprises a methylated hydrogen silsesquioxane (MHSQ) layer which adheres to

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said organosiloxane film and said inorganic material...". In response to this argument, the combination of the Yau, Allada and the prior art do teach upon the argued limitation for the reasons given hereinabove.


In regards to the applicants' arguments with respect to the Lu reference, these arguments have been considered but are moot in view of the new ground(s) of rejection.

Conclusion


13. Applicants are encouraged, where appropriate, to check Patent Application Information Retrieval (PAIR) (<http://portal.uspto.gov/external/portal/pair>) which provides applicants direct secure access to their own patent application status information, as well as to general patent information publicly available.

14. Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Julio J. Maldonado whose telephone number is (571) 272-1864. The examiner can normally be reached on Monday through Friday.

15. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith, can be reached on (571) 272-1907. The fax number for this group is 571-273-8300. Updates can be found at <http://www.uspto.gov/web/info/2800.htm>.


Julio J. Maldonado
November 29, 2006

Julio J. Maldonado
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